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DEPARTMENT: COMPUTER SCIENCE
COURSE: PHY 102 (COVID-19 HOLIDAY ASSIGNMENT)
MATRIC NO: 19/SCI01/086
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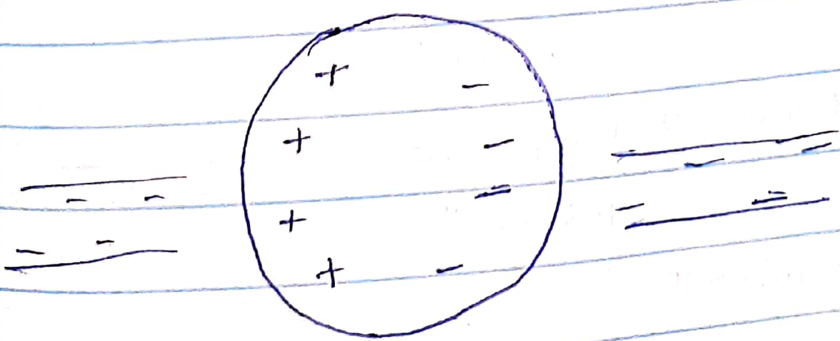
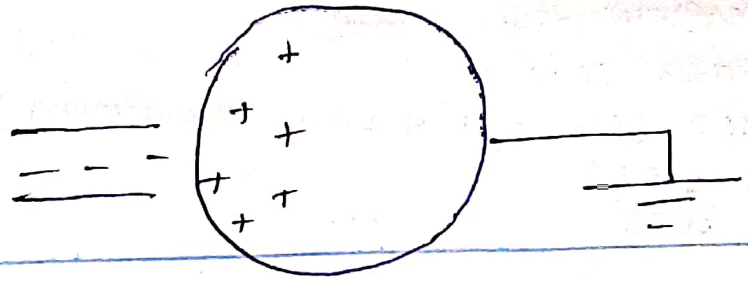
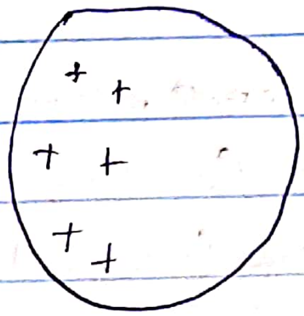
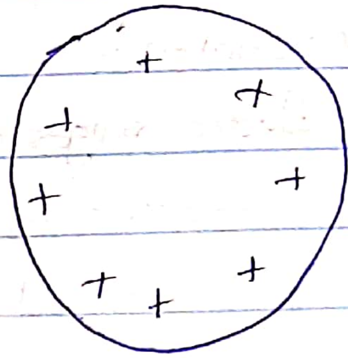
1a. How one can produce a negatively charged sphere by method of induction:

Electric charges can be obtained on an object without touching it, by a process called electrostatic induction. Consider a negatively charged rubber rod brought near a neutral (uncharged) conducting sphere that is insulated so that there is no conducting path to ground as shown below. The repulsive force between the electrons in the rod and those in the sphere causes ~~a redis~~ a redistribution of charges on the sphere so that some electrons move to the side of the sphere farthest away from the rod. The region of the sphere nearest the negatively charged rod has an excess of positive charge because of the migration of electrons away from the location. If ~~as~~ a grounded conducting wire is then connected to the sphere, as in the figure below, some of the electrons leave the sphere and travel to the earth. If the wire to the ground is then removed, the conducting sphere is left with an excess of induced positive charge









Finally, when the rubber rod is removed from the vicinity of the sphere, uniformly distributed over the surface of the sphere.

1b. $F = \frac{kq_1q_2}{r^2}$

$q_1 + q_2 = 5\times10^{-5}$

$1 = 9\times10^{9} \times q_1 \times (5\times10^{-5} - q_1)$

$4 = 450000q - 9\times10^{9} q^2$

$9\times10^{9} q^2 - 450000q + 4 = 0$

$-b + \text{or} - (b^2 - 4ac)^{1/2} / 2a$

$450000 + \text{or} - \frac{(-4500 + 4\times9\times10^{9}\times4)^{1/2}}{2(9\times10^{9})}$

$450000 + \text{or} - \frac{379{,}473.73}{1.8\times10^{10}}$

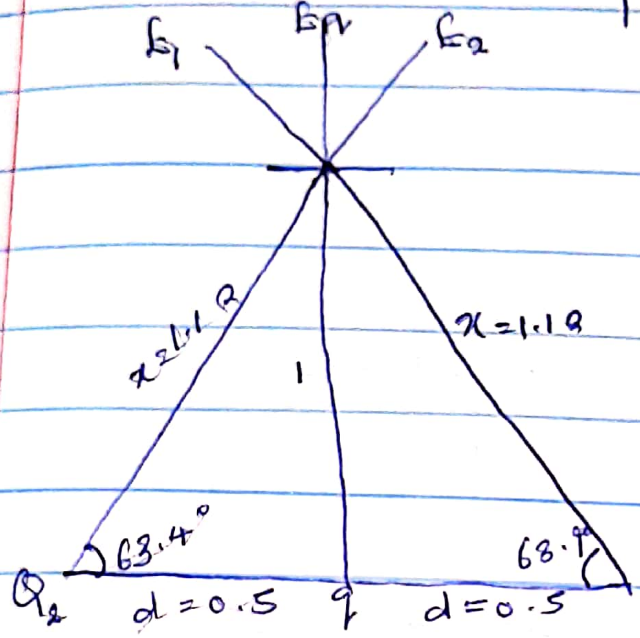
$q_1 = 4.61\times10^{-5}\,C$

$q_2 = 3.92\times10^{-6}\,C$

1c. $Q_1 = Q_2 = 8\mu C$

$d = 0.5m$

If electric field at a point P is zero.



$x^2 = 1^2 + 0.5^2$

$\sqrt{x^2} = \sqrt{1.25}$

$x = \sqrt{1.25} = 1.12$

$\tan\theta = \frac{1}{0.5}$

$\theta = \tan^{-1}(2)$

$\theta = 63.4$

$E_1 = \frac{Kq_1}{r^2} = \frac{9\times10^9 \times 8\times10^{-6}}{(1.12)^2} = 57397.9598$

2a. * Electric field is a region of space in which an electric charge will experience an electric force.

* Electric field intensity is defined as the force per unit charge.

2b. Given, $Q_1 = 8nC$

$Q_2 = 12nC$

$x = 4m$

i) $E_1 = \frac{Kq_1}{r^2} = \frac{9\times10^9 \times 8\times10^{-6}}{0^2}$

$= 7200 N/C$

$E_2 = \frac{Kq_2}{r^2} = \frac{9\times10^9 \times 12\times10^{-6}}{4^2}$

$= 6750 N/C$

$E_P = E_1 + E_2$

$= 7200 + 6750$

$= 13950 N/C$

ii) $E = \frac{13950}{2} = 6975$

$E = \frac{9\times10^9 \times 6975}{r^2}$

$= 6.975 \times 10^{12} N/C$

4a. Magnetic flux is defined as the strength of the magnetic field which can be represented by line of forces. It is represented by the symbol ϕ. Mathematically, $\phi = B \cdot dA$.

4b. $m = 9 \times 10^{-31}$ kg

$r = 1.4 \times 10^{-7}$ m

$B = 3.5 \times 10^{-1}$ weber/meter^2

cyclotron frequency = angular speed

$$\omega = \frac{V}{r} = \frac{qB}{m}$$

$$\omega = \frac{qB}{m} = \frac{1.6 \times 10^{-19} \times 3.5 \times 10^{-1}}{9 \times 10^{-31}}$$

$$\omega = 6.22 \times 10^{10} \ T^{-1}$$

4c. Mass of electron $= 9.11 \times 10^{-31}$ kg

5a. The Biot-Savart law is based on the following observations for the magnetic field db at a point P associated with a length element dl of a wire carrying a steady current.

5b. $B = \mu_0 I/4$pie integral power a subscript $-a$ $dl \sin(\text{pie} - \theta)/(x^2+y^2)$ ... (i)

$$\sin(\text{Pie} - \theta) = \frac{x}{(x^2+y^2)^{1/2}} = \frac{x}{(x^2+y^2)^{1/2}}$$

$B = \mu_0 I/4$pie integral power a subscript $-a$ $\dfrac{\cancel{x}}{(x^2+y^2)(x^2+y^2)}$

$B = \mu_0 I/4$pie integral power a subscript $-a$ $dl \dfrac{x}{(x^2+y^2)^{3/2}}$

Recall, $dl = dy$

$B = \mu_0 I/4$pie integral power a subscript $-a$ $\dfrac{x}{(x^2+y^2)^{3/2}} \times dy$

$B = \mu_0 I x/4$pie integral power a subscript $-a$ $1/(x^2+y^2)^{3/2} \times dy$ ...(ii)

Using Special Integral:

Integral $\dfrac{dy}{(x^2+y^2)^{3/2}} = 1/x^2 \times \dfrac{y}{(x^2+y^2)^{1/2}}$

Equation (ii) therefore becomes,

$B = \mu_0 I x/4$pie $\left[\cancel{\dfrac{y}{x^2(x^2+y^2)}} \quad \dfrac{y}{x^2(x^2+y^2)^{1/2}}\right]$ power a subscript $-a$.

$B = \mu_0 I x/4$pie $\left[\dfrac{2a}{x^2 (a^2+y^2)^{1/2}}\right]$

$B = \mu_0 I/4$pie $\times \left[\dfrac{2a}{(x^2+a^2)^{1/2}}\right]$

When the length 2a of the conductors is a great in comparison to its distance x from point P, we consider it infinitely long. That is, when 'a' is much larger than x, $(x^2+a^2)^{1/2} = a$, as to infinity

Therefore: $B = \mu_0 I/2$pie x

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